PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-283158
(43)Date of publication of application : 27.10.1995

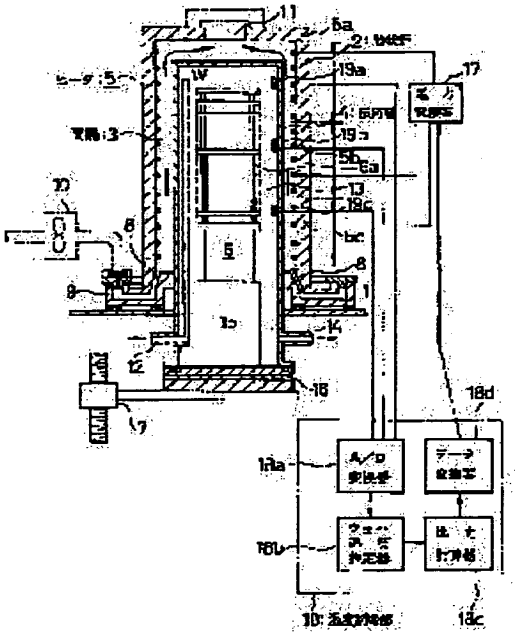
(51)Int.Cl. H01L 21/22
H01L 21/205

(21)Application number : 06-096951
(22)Date of filing : 11.04.1994

(71)Applicant : TOKYO ELECTRON LTD
TOKYO ELECTRON TOHOKU LTD
(72)Inventor : SUGANO SOICHI

(54) THERMAL TREATMENT DEVICE AND TEMPERATURE CONTROLLING METHOD THEREOF

(57)Abstract:
PURPOSE: To accurately and quickly control a thermal treatment device in temperature by a method wherein a work temperature and the dynamic characteristics of a temperature sensor are taken into consideration.
CONSTITUTION: The temperature of a work is estimated by a wafer temperature estimating device 18b basing on temperature data detected by a temperature sensor installed inside a reaction oven 4 by the use of an estimation formula which is previously approximated as a primary or secondary time-lag system using dummy wafers. A heating means 5 is controlled in output so as to make this estimate equal to a required temperature, so that the reaction oven can be more accurately and quickly controlled in temperature.



LEGAL STATUS

[Date of request for examination] 12.03.2001

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

(19)日本国特許庁（ＪＰ）　(12)**公開特許公報（Ａ）**　(11)特許出願公開番号

特開平7－283158

(43)公開日　平成７年(1995)10月27日

(51)Int.Cl.[6]	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｈ０１Ｌ　21/22	５１１　Ａ			
21/205				

審査請求　未請求　請求項の数６　ＦＤ　（全６頁）

(21)出願番号　特願平6－96951

(22)出願日　平成６年(1994)４月11日

(71)出願人　000219967
東京エレクトロン株式会社
東京都港区赤坂５丁目３番６号

(71)出願人　000109576
東京エレクトロン東北株式会社
岩手県江刺市岩谷堂字松長根52番地

(72)発明者　菅野　聡一
岩手県江刺市岩谷堂字松長根52番地　東京エレクトロン東北株式会社東北事業所内

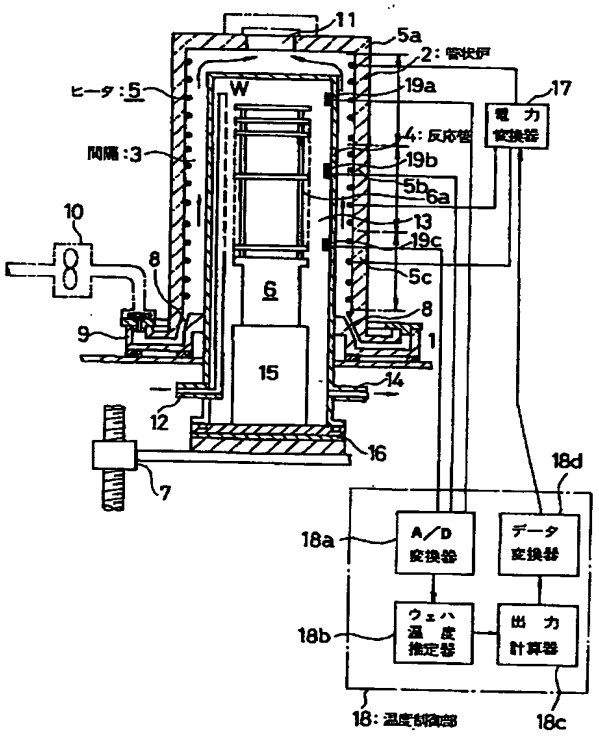
(74)代理人　弁理士　亀谷　美明　（外１名）

(54)【発明の名称】　熱処理装置およびその温度制御方法

(57)【要約】

【目的】　被処理体温度と温度センサとの動特性を考慮することにより、正確かつ迅速な温度制御を行う。

【構成】　本発明によれば、反応炉４内の温度センサ１９により検出された温度データを基に、ウェハ温度推定器１８ｂにおいて、予めダミーウェハを用いて一次または二次の遅れ系として近似された推定式に基づいて、ウェハ温度が推定される。そしてこの推定値と所望の温度とが一致するように加熱手段５の出力が調整されるので、より正確かつ迅速な温度制御を行うことが可能である。



【特許請求の範囲】

【請求項１】　処理室内に配列された被処理体を、その処理室の外部に設置された温調手段により昇温して、その処理室内に導入された処理ガスにより熱処理するための熱処理装置において、

前記処理室の内部および／または外部に設置されている温度検出手段からの信号に基づいて被処理体の温度を動的に推定する推定器と、

その推定器による推定値に基づいて、前記時系列データに基づいて前記温調手段の出力を演算し制御するための温度制御器とを備えたことを特徴とする、熱処理装置。

【請求項２】　前記推定器による被処理体の温度の推定が次式により行われ、

【数１】

$$W(n)=\sum_{i=0}^{k} aiT(n-i)$$

ただし、Ｗ（ｎ）：時点ｎにおける被処理体温度の推定値；

Ｔ（ｎ）：時点ｎにおける温度検出手段による測定温度；

$a_0 \cdots a_k$：測定温度と被処理体温度の動特性を規定する定数；

であり、測定温度と被処理体温度の動特性を規定する定数（$a_0 \cdots a_k$）が温度検出手段を備えたダミーウェハに対して被処理体と実質的に同一の熱処理を施すことにより予め獲得されていることを特徴とする、請求項１に記載の熱処理装置。

【請求項３】　前記処理室を複数の加熱ゾーンに分割し、各加熱ゾーンごとに対応する推定器と温度制御器とを設けたことを特徴とする、請求項１または２のいずれかに記載の熱処理装置。

【請求項４】　処理室内に配置された被処理体を、その処理室の外部に設置された温調手段により昇温して、その処理室内に導入された処理ガスにより熱処理するにあたり、

処理室の内部および／または外部の温度と被処理体温度との動特性を予め獲得し、その動特性に基づいて実際の被処理体温度を推定し、その推定値に基づいて前記温調手段の出力を制御することを特徴とする、熱処理装置の温度制御方法。

【請求項５】　被処理体温度の推定が次式に基づいて行われ、

【数２】

$$W(n)=\sum_{i=0}^{k} aiT(n-i)$$

ただし、Ｗ（ｎ）：時点ｎにおける被処理体温度の推定値；

Ｔ（ｎ）：時点ｎにおける温度検出手段による測定温度；

$a_0 \cdots a_k$：測定温度と被処理体温度の動特性を規定する定数；

であり、測定温度と被処理体温度の動特性を規定する定数（$a_0 \cdots a_k$）が温度検出手段を備えたダミーウェハに対して被処理体と実質的に同一の熱処理を施すことにより予め獲得されていることを特徴とする、請求項４に記載の熱処理装置。

【請求項６】　前記温調手段による加熱領域が複数ゾーンに分割されており、各ゾーンごとに処理室の内部および／または外部の温度と被処理体温度との動特性が求められ、各動特性に基づいて実際の被処理体温度が推定され、その推定値に基づいて各ゾーンに対応する温調手段の出力が制御されることを特徴とする、請求項４または５のいずれかに記載の熱処理装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、熱処理装置およびその温度制御方法に関する。

【０００２】

【従来の技術】従来より、半導体製造工程においては、被処理体である半導体ウェハの表面に薄膜や酸化膜を積層したり、あるいは不純物の拡散を行うためにＣＶＤ装置、酸化膜形成装置、あるいは拡散装置などが用いられており、最近では、精度の高い処理を行うために、縦型の熱処理炉が使用されている。この縦型の熱処理炉は、一般に加熱用の管状炉を垂直に配置し、この管状炉の中に石英などからなる反応管を（処理室）設け、多数の半導体ウェハなどの被処理体を水平状態で縦方向に収容したボートを適当な昇降装置によって上昇させて上記反応管内に搬入し、処理室内に導入される適当な反応ガスにより、酸化膜形成などの所定の熱処理を炉内で実施するように構成されている。

【０００３】そして、集積回路の高速化、高集積化に伴って半導体ウェハ表面の処理を高精度で制御する必要があるが、そのためには加熱処理時の温度制御の精度を高めることが重要である。例えば、被処理体である半導体ウェハを短時間で所定温度例えば５００℃から所定温度例えば１０００℃まで上昇させるとともに、処理中は所定温度例えば１０００℃に保持し、処理終了後には再び短時間で所定温度例えば５００℃まで下降させてやる必要がある。

【０００４】ところで、従来の縦型加熱炉の構成では、処理中に被処理体の温度を直接測定することができないため、処理室の内部および／または外部に設置された温度検出手段を利用して、間接的に炉内の温度または被処理体の温度を推定し、その温度を制御する方法が採用されている。

【０００５】その際に、従来の温度制御方法では、処理室の内部および／または外部に設置された温度検出手段により測定された温度データと、被処理体の温度データを静的に比較し、設定温度のプロファイルを求め、その

プロファイルに沿って温調手段の出力を制御していた。

【０００６】

【発明が解決しようとする課題】しかしながら、実際には被処理体温度と処理室の内部または外部の温度とは互いに静特性を維持しながら推移して行く訳ではないので、それらの静特性にのみ着目して被処理体温度を推定し、加熱手段の出力を制御した場合には、実際の被処理体温度と推定された被処理体温度との間に乖離が生じ、正確かつ迅速な温度制御を行うことができず問題となっていた。

【０００７】本発明は上記のような従来の熱処理装置およびその温度制御方法の有する問題点に鑑みてなされたものであり、その目的とするところは、被処理体温度と処理室の内部および／または外部の温度との動特性を考慮することにより、より正確かつ迅速な処理室内温度または被処理体温度の制御を行うことが可能な新規かつ改良された熱処理装置およびその温度制御方法を提供することである。

【０００８】

【課題を解決するための手段】上記課題を解決するために、請求項１に記載の発明は、処理室内に配列された被処理体を、その処理室の外部に設置された温調手段により昇温して、その処理室内に導入された処理ガスにより熱処理するための熱処理装置において、前記処理室の内部および／または外部に設置されている温度検出手段からの信号に基づいて被処理体の温度を動的に推定する推定器と、その推定器による推定値に基づいて、前記時系列データに基づいて前記温調手段の出力を演算し制御するための温度制御器とを備えたことを特徴としている。

【０００９】また請求項２に記載のように、上記推定器により被処理体の温度を推定する場合には、次式を用いることが好ましく、

【００１０】

【数３】

$$W(n)=\sum_{i=0}^{k} aiT(n-i)$$

【００１１】ただし、Ｗ（ｎ）：時点ｎにおける被処理体温度の推定値；

Ｔ（ｎ）：時点ｎにおける温度検出手段による測定温度；

$a_0 \cdots a_k$：測定温度と被処理体温度の動特性を規定する定数；

であり、その際、測定温度と被処理体温度の動特性を規定する定数（$a_0 \cdots a_k$）が温度検出手段を備えたダミーウェハに対して被処理体と実質的に同一の熱処理を施すことにより予め獲得されていることが好ましい。

【００１２】さらにまた請求項３に記載のように、処理室を複数の加熱ゾーンに分割した構成の場合には、各加熱ゾーンごとに対応する推定器と温度制御器とを設けて温度制御することが好ましい。

【００１３】さらに請求項４によれば、処理室内に配置された被処理体を、その処理室の外部に設置された温調手段により昇温して、ぞの処理室内に導入された処理ガスにより熱処理するにあたり、処理室の内部および／または外部の温度と被処理体温度との動特性を予め獲得し、その動特性に基づいて実際の被処理体温度を推定し、その推定値に基づいて前記温調手段の出力を制御することを特徴とする、熱処理装置の温度制御方法が提供される。

【００１４】そして被処理体温度を推定する場合には、請求項５に記載のように、次式を用いて推定が行われることが好ましく、

【００１５】

【数４】

$$W(n)=\sum_{i=0}^{k} aiT(n-i)$$

【００１６】ただし、Ｗ（ｎ）：時点ｎにおける被処理体温度の推定値；

Ｔ（ｎ）：時点ｎにおける温度検出手段による測定温度；

$a_0 \cdots a_k$：測定温度と被処理体温度の動特性を規定する定数；

であり、その際にも、測定温度と被処理体温度の動特性を規定する定数（$a_0 \cdots a_k$）が温度検出手段を備えたダミーウェハに対して被処理体と実質的に同一の熱処理を施すことにより予め獲得されていることが好ましい。

【００１７】さらにまた請求項６に記載のように、前記温調手段による加熱領域が複数ゾーンに分割されている構成の場合には、各ゾーンごとに処理室の内部および／または外部の温度と被処理体温度との動特性を求め、各動特性に基づいて実際の被処理体温度を推定し、その推定値に基づいて各ゾーンに対応する温調手段の出力を制御することが好ましい。

【００１８】

【作用】本発明は上記のように構成されているので、以下に述べるような優れた作用効果を奏することが可能である。すなわち、本発明によれば、処理室の内部および／または外部温度と被処理体温度との動特性が考慮されて、被処理体の温度が推定され、その推定値に基づいて温調手段の出力が調整されるので、実際の被処理体温度を所望の処理温度により正確かつ迅速に制御することができる。

【００１９】また、温度検出手段が設置されたダミーウェハを用いて、実際の処理時には知ることのできない被処理体の温度を求め、その被処理体の温度と処理室の内部および／または外部温度との動特性を一次あるいは二次の遅れ系の関数で近似することができるので、より簡便に被処理体の温度を推定することができる。

【００２０】さらに、複数の加熱ゾーンを有する構成の場合であっても、各ゾーンごとに被処理体の温度を動的

に推定するので、より均一な処理温度でバッチ式の熱処理を行うことができる。

【００２１】

【実施例】以下に添付図面を参照しながら本発明に基づいて構成された熱処理装置を縦型の減圧ＣＶＤ装置に適用した一実施例について詳細に説明する。

【００２２】図１に示す減圧ＣＶＤ装置は縦型熱処理炉として構成され、水平に固定された基台１上に垂直に支持された断熱性の頂部を有する略円筒形状の管状炉２と、その管状炉２の内側に所定の間隔３を空けて挿入された石英などからなる頂部を有する略円筒形状の反応管４と、上記管状炉２の内周壁に螺旋状に配設された例えば抵抗発熱体などのヒータよりなる加熱手段５と、複数の被処理体、例えば半導体ウェハ（またはダミーウェハ）Ｗを水平状態で垂直方向に多数配列保持することが可能な石英などからなるウェハボート６と、このウェハボート６を昇降するための昇降機構７とから主要部が構成されている。

【００２３】さらに上記管状炉２の底部には上記間隔３に連通する吸気口８が設置されており、適当なマニホルド９を介して接続された給気ファン１０により上記間隔３内に冷却空気を供給することが可能である。また上記管状炉２の頂部には同じく上記間隔３に連通する排気口１１が設置されており、上記間隔３内の空気を排気することが可能なように構成されている。

【００２４】また上記反応管４の底部には図示しないガス源に流量制御装置を介して接続された反応ガス供給管路１２が設けられており、上記反応管４の内部の処理室１３に所定の反応ガスを導入することが可能である。さらに上記反応管４の底部には図示しない真空ポンプなどの排気手段に接続された排気管路１４が接続されており、上記処理室１３内を所定の圧力に真空引きすることが可能なように構成されている。

【００２５】また上記ウェハボート６は、半導体ウェハ（またはダミーウェハ）Ｗを多段状に保持する保持部６ａの下に保温筒１５を介して蓋体１６を備えており、上記昇降機構７により上記ウェハボート６を上昇させることにより、上記蓋体１６が上記反応管４の底部の開口を気密に封止することが可能なので、処理時には上記処理室１３内を上記排気管路１４を用いて真空引きし、さらに上記排気管路１０からの排気を行いつつ上記反応ガス供給管路１２から所定の反応ガスを上記処理室１３内に導入することが可能なように構成されている。

【００２６】次に上記のように構成された縦型熱処理炉の温度制御系について説明する。温度制御系は、半導体ウェハＷの配列方向に沿って複数（図示の例では上部、中央部、下部）に分割配置される上部ヒータ５ａ、中央部ヒータ５ｂおよび下部ヒータ５ｃと、それらのヒータの加熱量を制御するための電力変換器１７、たとえばＳＣＲと、その電力変換器１７を制御するための温度制御部１８とから構成されている。

【００２７】そして温度制御部１８は、後述するように反応管４内の各加熱ゾーンごとに設置される温度センサ１９ａ、１９ｂ、１９ｃ、たとえば白金／白金／ロジウムからなるＲタイプの熱電対から送られてくる起電力をディジタルの起電力（温度）データに変換するためのＡ／Ｄ変換器１８ａと、上記温度データから後述する推定式に基づいてウェハ温度を推定するウェハ温度推定器１８ｂと、ウェハ温度推定器で推定したウェハ温度を基にヒータに対する出力指令値を、たとえばＰＩＤアルゴリズムにより計算する出力計算器１８ｃと、ディジタル値としてヒータに対する指令値を電力変換器１７の入力仕様に適合する信号に変換するためのデータ変換器１８ｄとから構成されている。

【００２８】なお図示の例では、加熱ゾーンを３つに分割し、各加熱ゾーンに対して反応管４の内部にそれぞれ対応する温度センサを設置する構成を採用しているが、本発明はかかる構成に限定されない。たとえば、単一の加熱手段により処理室内を加熱する処理装置、あるいは任意の数のゾーンに分割された処理装置に対しても適用可能である。また温度センサについても、上記実施例では、反応管４内部の各加熱ゾーンに対応して設置しているが、本発明はかかる構成に限定されない。たとえば、反応管４の外部の温度センサを設ける構成を採用することも可能であり、後述するように、温度センサにより検出された温度と処理室温度または被処理体温度との動的関連づけを推定器１８ｂにより行うことが可能であれば、温度センサは任意数を処理室の内部および／または外部の任意の場所に設置することが可能である。

【００２９】次に上記のように形成された減圧ＣＶＤ装置の動作について図１を参照しながら説明する。

【００３０】１．推定式の確定

まず本発明によれば、温度センサが設置されたダミーウェハを各加熱ゾーンごとに設置して、実際の熱処理と同様の処理を行い、最適なダミーウェハ温度と反応管４内に設置された温度センサ１９ａ、１９ｂ、１９ｃにより検出された温度との動的な関係式を求める必要がある。すなわち、実際の熱処理と同様に、まず管状炉２の内壁に設置された加熱装置５に電力を印加して、反応管４を加熱して、その内部温度をたとえば５００℃にまで上昇させる。ついで蓋体１６を開放して、各加熱ゾーンに対応する位置にダミーウェハが設置されたウェハボート６をロードする。このボートロード動作の開始とともに、反応管４の内部が外気と連通するため、反応管４内の温度が下降するが、ボートロード動作が終了し蓋体１６が閉止されることにより、反応管４内の温度は上昇に転じ、所定時間終了後に再び５００℃に収束する。その後、さらに処理温度、たとえば６００℃にまで上昇させた後、たとえばSiH_4ガスなどの処理ガスが反応ガス供給管路１２から導入されて、ダミーウェハに対して、

たとえば0．１Ｔｏｒｒの減圧雰囲気でポリシリコンの成膜処理を行い、所定の熱処理が終了した後、再び蓋体１６を開放し、ウェハボート６を反応管４から取り出し、蓋体１６を閉止することにより、一連の動作を終了する。

【００３１】そして、本発明によれば、上記熱処理が行われている間、ダミーウェハに設置された温度検出器により、各ゾーンごとにダミーウェハの温度が最適になるように各ゾーンの加熱装置５ａ、５ｂ、５ｃの出力が制御され、その際のダミーウェハの温度と反応管４の内部温度センサ１９ａ、１９ｂ、１９ｃとの動的関係が、次の推定式により近似され、ウェハ温度推定器１８ｂに格納される。

【００３２】

【数５】

$$W(n)=\sum_{i=0}^{k} a_i T(n-i)$$

【００３３】ただし、Ｗ（ｎ）：時点ｎにおける被処理体温度の推定値；

Ｔ（ｎ）：時点ｎにおける温度検出手段による測定温度；

$a_0 \cdots a_k$：測定温度と被処理体温度の動特性を規定する定数；

【００３４】２．処理モード

実際に処理を行う場合には、まず管状炉２の内壁に設置された加熱装置５に電力を印加して、反応管４を加熱して、その内部温度をたとえば５００℃にまで上昇させる。ついで蓋体１６を開放して、各加熱ゾーンに対応する位置に被処理体である半導体ウェハＷが所定枚数設置されたウェハボート６をロードする。そして、反応管４内を所定の圧力、たとえば0．１Ｔｏｒｒに減圧した状態で、処理ガス、たとえばSiH_4ガスなどを反応ガス供給管路１２から導入することにより、被処理体に所望のポリシリコンの成膜処理を施すことが可能である。そして所定の熱処理が終了した後、処理ガスの供給を停止し、蓋体１６を開放し、ウェハボート６を反応管４から取り出し、蓋体１６を閉止することにより、一連の動作を終了する。

【００３５】上記のような熱処理装置の温度制御を行う際に、本発明によれば、反応管４内部に設置された温度センサ１９ａ、１９ｂ、１９ｃにより反応管内部の温度が監視されており、それらの温度センサ１９ａ、１９ｂ、１９ｃ、たとえば熱電対の起電力信号がＡ／Ｄ変換器１８ａにより一定時間間隔の温度データに変換され、その温度データからウェハ温度推定器１８ｂにおいて、上記推定式に基づいてウェハ温度が動的に推定される。そして、上記ウェハ温度推定器１８ｂにおいて推定されたウェハ温度を基にヒータなどの加熱手段５に対する出力指令値が、たとえばＰＩＤアルゴリズムを用いて計算され、さらにディジタル値としてのヒータに対する出力指令値がＳＣＲなどの電力変換器１７の入力仕様に適合するようにデータ変換器１８ｄに送られ、そこからの信号に基づいて電力変換器１７の出力が調整されて、各加熱ゾーンに対応する加熱手段５ａ、５ｂ、５ｃの出力が調整される。

【００３６】以上のような演算メカニズムを用いて、本発明によれば、温度センサからの信号を基に各時点のウェハ温度が動的に推定されるので、従来の方法よりも遥かに正確かつ迅速に所望の温度制御を行うことができる。

【００３７】次に、図２および図３を参照しながら、上記のように構成され動作する本発明の優れた効果について説明する。たとえば、従来のように温度センサからの信号により静的にウェハ温度を推定した場合には、図２に実線で示すランプアップ曲線に沿って昇温させようとしたときに一点鎖線で示すような温度変化が検出された場合には、たとえばウェハ温度は点線で示すように検出温度よりもΔｔ℃だけ高いものと推定され、それに基づいて温度制御が行われるが実際には、ウェハ温度は二点鎖線で示すように遅れ系を示すため、正確かつ迅速な温度制御を行うことができないのが実状であった。

【００３８】しかしながら、本発明によれば、図３に実線で示すようなランプアップ曲線に沿って昇温させようとしたときに、一点鎖線で示すような温度変化が検出された場合には、たとえばウェハ温度は点線で示すように、二点鎖線で示したウェハ温度に近い値と推定され、それに基づいて温度制御が行われるため、より正確かつ迅速な温度制御を行うことが可能になる。

【００３９】なお以上の実施例においては、バッチ式の減圧ＣＶＤ装置を例に挙げて本発明を説明したが、本発明はかかる実施例に限定されず、常圧ＣＶＤ装置、拡散装置、酸化装置、成膜装置、さらには枚葉式の熱処理装置に対しても適用することが可能であることは言うまでもない。

【００４０】

【発明の効果】以上説明したように、本発明によれば、処理室の内部および／または外部温度と被処理体温度との動特性が考慮されて、被処理体の温度が推定され、その推定値に基づいて温調手段の出力が調整されるので、実際の被処理体温度を所望の処理温度により正確かつ迅速に制御することができる。

【００４１】また、温度検出手段が設置されたダミーウェハを用いて、実際の処理時には知ることのできない被処理体の温度を求め、その被処理体の温度と処理室の内部および／または外部温度との動特性を一次あるいは二次の遅れ系の関数で近似することができるので、より簡便に被処理体の温度を推定することができる。

【００４２】さらに、複数の加熱ゾーンを有する構成の場合であっても、各ゾーンごとに被処理体の温度を動的に推定するので、より均一な処理温度でバッチ式の熱処

理を行うことができる。

【図面の簡単な説明】

【図１】本発明に基づいて構成された熱処理装置を縦型の減圧ＣＶＤ装置に適用した一実施例を示す概略的な断面図である。

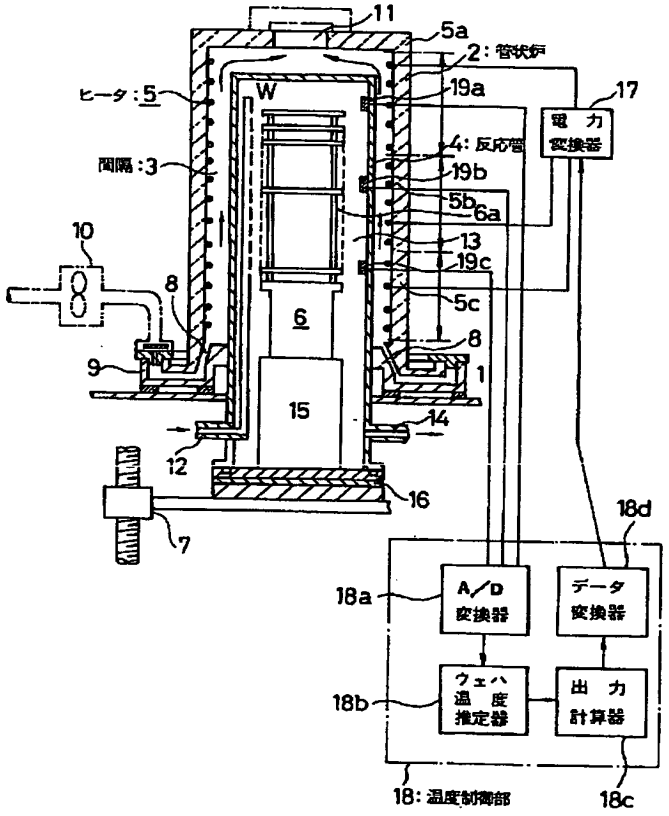
【図２】従来の静的推定方法によるウェハ温度制御の様子を示す説明図である。

【図３】本発明に基づく動的推定方法によるウェハ温度制御の様子を示す説明図である。

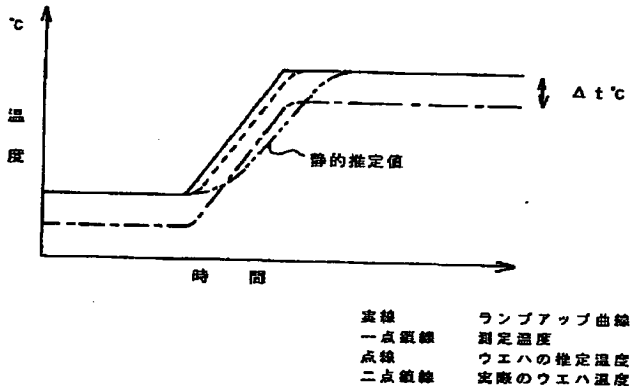
【符号の説明】

２	管状炉
４	反応管
５	加熱装置
１７	電力変換器
１８	温度制御部
１８ａ	Ａ／Ｄ変換器
１８ｂ	ウェハ温度推定器
１８ｃ	出力計算器
１８ｄ	データ変換器

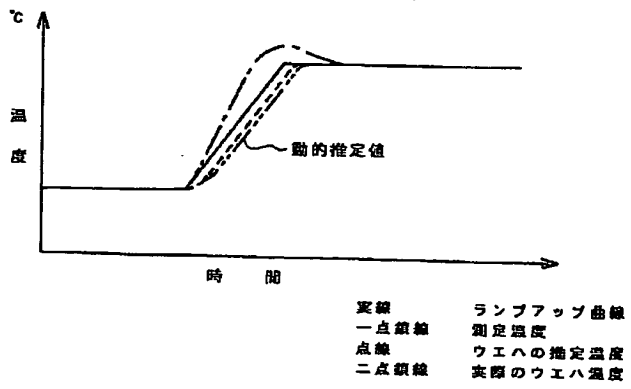
【図１】



【図２】



【図３】



【公報種別】特許法第１７条の２の規定による補正の掲載
【部門区分】第７部門第２区分
【発行日】平成１３年１１月９日（２００１．１１．９）

【公開番号】特開平７－２８３１５８
【公開日】平成７年１０月２７日（１９９５．１０．２７）
【年通号数】公開特許公報７－２８３２
【出願番号】特願平６－９６９５１
【国際特許分類第７版】
H01L 21/22 511
21/205
【ＦＩ】
H01L 21/22 511 A
21/205

【手続補正書】
【提出日】平成１３年３月１２日（２００１．３．１２）
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】請求項１
【補正方法】変更
【補正内容】
【請求項１】　処理室内に配列された被処理体を、その処理室の外部に設置された温調手段により昇温して、その処理室内に導入された処理ガスにより熱処理するための熱処理装置において、
前記処理室の内部および／または外部に設置されている温度検出手段からの信号に基づいて被処理体の温度を推定する推定器と、
その推定器による推定値に基づいて前記温調手段の出力を演算し制御するための温度制御器とを備えたことを特徴とする、熱処理装置。
【手続補正２】
【補正対象書類名】明細書
【補正対象項目名】請求項４
【補正方法】変更
【補正内容】
【請求項４】　処理室内に配置された被処理体を、その処理室の外部に設置された温調手段により昇温して、その処理室内に導入された処理ガスにより熱処理するにあたり、
処理室の内部および／または外部の温度と被処理体温度との動特性を予め獲得し、その動特性に基づいて実際の被処理体温度を推定し、その推定値に基づいて前記温調手段の出力を制御することを特徴とする、熱処理装置の温度制御方法。
【手続補正３】
【補正対象書類名】明細書
【補正対象項目名】０００８
【補正方法】変更
【補正内容】
【０００８】
【課題を解決するための手段】上記課題を解決するために、請求項１に記載の発明は、処理室内に配列された被処理体を、その処理室の外部に設置された温調手段により昇温して、その処理室内に導入された処理ガスにより熱処理するための熱処理装置において、前記処理室の内部および／または外部に設置されている温度検出手段からの信号に基づいて被処理体の温度を推定する推定器と、その推定器による推定値に基づいて前記温調手段の出力を演算し制御するための温度制御器とを備えたことを特徴としている。
【手続補正４】
【補正対象書類名】明細書
【補正対象項目名】００１３
【補正方法】変更
【補正内容】
【００１３】さらに請求項４によれば、処理室内に配置された被処理体を、その処理室の外部に設置された温調手段により昇温して、その処理室内に導入された処理ガスにより熱処理するにあたり、処理室の内部および／または外部の温度と被処理体温度との動特性を予め獲得し、その動特性に基づいて実際の被処理体温度を推定し、その推定値に基づいて前記温調手段の出力を制御することを特徴とする、熱処理装置の温度制御方法が提供される。

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-283158
(43)Date of publication of application : 27.10.1995

(51)Int.Cl. H01L 21/22
H01L 21/205

(21)Application number : 06-096951

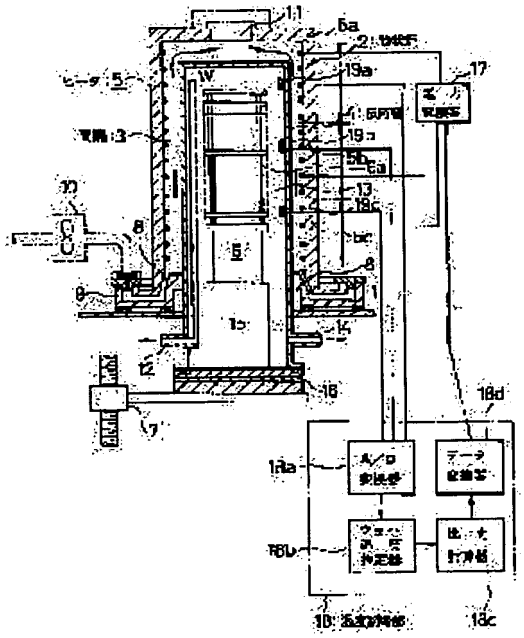
(22)Date of filing : 11.04.1994

(71)Applicant : TOKYO ELECTRON LTD
TOKYO ELECTRON TOHOKU LTD

(72)Inventor : SUGANO SOICHI

(54) THERMAL TREATMENT DEVICE AND TEMPERATURE CONTROLLING METHOD THEREOF

(57)Abstract:
PURPOSE: To accurately and quickly control a thermal treatment device in temperature by a method wherein a work temperature and the dynamic characteristics of a temperature sensor are taken into consideration.
CONSTITUTION: The temperature of a work is estimated by a wafer temperature estimating device 18b basing on temperature data detected by a temperature sensor installed inside a reaction oven 4 by the use of an estimation formula which is previously approximated as a primary or secondary time-lag system using dummy wafers. A heating means 5 is controlled in output so as to make this estimate equal to a required temperature, so that the reaction oven can be more accurately and quickly controlled in temperature.



LEGAL STATUS

[Date of request for examination] 12.03.2001

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] In the thermal treatment equipment for heat-treating the processed object arranged in the processing interior of a room with the raw gas which carried out the temperature up with the temperature control means installed in the exterior of the processing room, and was introduced into the processing interior of a room The presumed machine which presumes the temperature of a processed object dynamically based on the signal from the temperature detection means currently installed in the interior and/or the exterior of said processing room, The thermal treatment equipment characterized by having a temperature selector for calculating and controlling the output of said temperature control means based on said time series data based on estimate with the presumed machine.
[Claim 2] Presumption of the temperature of a processed object with said presumed machine is performed by the degree type, and it is [Equation 1].
$$W(n) = \sum_{i=0}^{k} aiT(n-i)$$

However, estimate of whenever [processed temperature / in / a W(n):time / n];
T(n): Measurement temperature by the temperature detection means [in / a time / n];
a0 --ak: Constant which specifies the dynamic characteristics of measurement temperature and whenever [processed temperature];
The thermal treatment equipment according to claim 1 which comes out, exists and is characterized by being beforehand gained by performing the same heat treatment substantially with a processed object to the dummy wafer with which the constant (a0 -- ak) which specifies the dynamic characteristics of measurement temperature and whenever [processed temperature] was equipped with the temperature detection means.
[Claim 3] A thermal treatment equipment given in either of claims 1 or 2 which divides said processing room into two or more heating zones, and is characterized by forming the presumed machine which corresponds for every heating zone, and a temperature selector.
[Claim 4] The temperature up of the processed object arranged in the processing interior of a room is carried out with the temperature control means installed in the exterior of the processing room. In heat-treating with the raw gas introduced into the processing interior of a room of **, the dynamic characteristics of the temperature of the interior of a processing room and/or the exterior and whenever [processed temperature] is acquired beforehand. The temperature control approach of a thermal treatment equipment which presumes whenever [actual processed temperature] based on the dynamic characteristics, and is characterized by controlling the output of said temperature control means based on the estimate.
[Claim 5] Presumption of whenever [processed temperature] is performed based on a degree type, and it is [Equation 2].
$$W(n) = \sum_{i=0}^{k} aiT(n-i)$$

However, estimate of whenever [processed temperature / in / a W(n):time / n];
T(n): Measurement temperature by the temperature detection means [in / a time / n];
a0 --ak: Constant which specifies the dynamic characteristics of measurement temperature and whenever [processed temperature];
The thermal treatment equipment according to claim 4 which comes out, exists and is characterized by being

beforehand gained by performing the same heat treatment substantially with a processed object to the dummy wafer with which the constant (a0 -- ak) which specifies the dynamic characteristics of measurement temperature and whenever [processed temperature] was equipped with the temperature detection means.
[Claim 6] A thermal treatment equipment given in either of claims 4 or 5 which the heating field by said temperature control means is divided into two or more zones, the dynamic characteristics of the temperature of the interior of a processing room and/or the exterior and whenever [processed temperature] is searched for for every zone, and whenever [actual processed temperature] is presumed based on each dynamic characteristics, and is characterized by controlling the output of the temperature control means corresponding to each zone based on the estimate.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to a thermal treatment equipment and its temperature control approach.
[0002]
[Description of the Prior Art] From before, in order to carry out the laminating of a thin film or the oxide film to the front face of the semi-conductor wafer which is a processed object or to diffuse an impurity in a semi-conductor production process, a CVD system, oxide-film formation equipment, or dispersion equipment is used, and recently, in order to perform high processing of precision, the heat treating furnace of a vertical mold is used. Generally the heat treating furnace of this vertical mold arranges the tube furnace for heating perpendicularly, and the coil which consists of a quartz etc. is formed into this tube furnace (processing room). The boat which held processed objects, such as many semi-conductor wafers, in the lengthwise direction in the level condition is raised with a suitable lifting device, and it carries in within [above-mentioned] a reaction, and it is constituted by the suitable reactant gas introduced into the processing interior of a room so that predetermined heat treatment of oxide-film formation etc. may be carried out in a furnace.
[0003] And although it is necessary to control processing of a semi-conductor wafer front face by high degree of accuracy with improvement in the speed of an integrated circuit, and high integration, it is important to raise the precision of the temperature control at the time of heat-treatment for that purpose. For example, while raising the semi-conductor wafer which is a processed object for a short time to predetermined temperature, for example, the predetermined temperature from 500 degrees C, for example, 1000 degrees C, it is necessary to hold to predetermined temperature, for example, 1000 degrees C, and to make it descend to predetermined temperature, for example, 500 degrees C, again after processing termination during processing for a short time.
[0004] By the way, with the configuration of the conventional vertical mold heating furnace, since temperature of a processed object cannot be measured directly during processing, using the temperature detection means installed in the interior and/or the exterior of a processing room, the temperature in a furnace or the temperature of a processed object is presumed indirectly, and the approach of controlling the temperature is adopted.
[0005] On that occasion, the temperature data measured by the temperature detection means installed in the interior and/or the exterior of a processing room were statically compared with the temperature data of a processed object, it asked for the profile of laying temperature, and the output of a temperature control means was controlled by the conventional temperature control approach along with the profile.
[0006]
[Problem(s) to be Solved by the Invention] However, in fact, since the temperature of the interior of whenever [processed temperature], and a processing room or the exterior changes and does not necessarily go, maintaining the static characteristic mutually When whenever [processed temperature] was presumed only paying attention to those static characteristics and the output of a heating means was controlled, deviation arose between whenever [processed temperature / which was presumed to be whenever / actual processed temperature], and exact and quick temperature control could not be performed, but it had become a problem.
[0007] The place which this invention is made in view of the trouble which the above conventional thermal treatment equipment and its temperature control approach have, and is made into the purpose is a thing which can perform control of whenever [more exact and quick processing room air temperature], or whenever [processed temperature] and for which new, the improved thermal treatment equipment, and its temperature

control approach are offered by taking into consideration dynamic characteristics with the temperature of the interior of whenever [processed temperature], and a processing room, and/or the exterior.
[0008]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, invention according to claim 1 In the thermal treatment equipment for heat-treating the processed object arranged in the processing interior of a room with the raw gas which carried out the temperature up with the temperature control means installed in the exterior of the processing room, and was introduced into the processing interior of a room The presumed machine which presumes the temperature of a processed object dynamically based on the signal from the temperature detection means currently installed in the interior and/or the exterior of said processing room, It is characterized by having a temperature selector for calculating and controlling the output of said temperature control means based on said time series data based on estimate with the presumed machine.
[0009] Moreover, it is desirable to use a degree type like, in [according to claim 2] presuming the temperature of a processed object with the above-mentioned presumed vessel, and it is [0010].
[Equation 3]
$$W(n) = \sum_{i=0}^{k} aiT(n-i)$$

[0011] However, estimate of whenever [processed temperature / in / a W(n):time / n];
T(n): Measurement temperature by the temperature detection means [in / a time / n];
a0 --ak: Constant which specifies the dynamic characteristics of measurement temperature and whenever [processed temperature];
It comes out, and it is and being gained beforehand is desirable by performing the same heat treatment substantially with a processed object to the dummy wafer with which the constant (a0 -- ak) which specifies the dynamic characteristics of measurement temperature and whenever [processed temperature] was equipped with the temperature detection means in that case.
[0012] In a configuration of having divided the processing room into two or more heating zones like according to claim 3, it is desirable to form and carry out temperature control of the presumed machine and temperature selector which correspond for every heating zone further again.
[0013] Furthermore, the temperature up of the processed object which has been arranged in the processing interior of a room according to claim 4 is carried out with the temperature control means installed in the exterior of the processing room. In heat-treating with the raw gas introduced into the processing interior of a room of **, the dynamic characteristics of the temperature of the interior of a processing room and/or the exterior and whenever [processed temperature] is acquired beforehand. Whenever [actual processed temperature] is presumed based on the dynamic characteristics, and the temperature control approach of a thermal treatment equipment characterized by controlling the output of said temperature control means based on the estimate is offered.
[0014] And when presuming whenever [processed temperature], a thing [that presumption is performed using a degree type] according to claim 5 is [like] desirable, and it is [0015].
[Equation 4]
$$W(n) = \sum_{i=0}^{k} aiT(n-i)$$

[0016] However, estimate of whenever [processed temperature / in / a W(n):time / n];
T(n): Measurement temperature by the temperature detection means [in / a time / n];
a0 --ak: Constant which specifies the dynamic characteristics of measurement temperature and whenever [processed temperature];
Being gained beforehand is desirable by performing the same heat treatment substantially with a processed object to the dummy wafer with which the constant (a0 -- ak) which comes out, exists and specifies the dynamic characteristics of measurement temperature and whenever [processed temperature] also in that case was equipped with the temperature detection means.
[0017] In a configuration of that the heating field according to claim 6 according to said temperature control means like is divided into two or more zones, it is desirable to search for the dynamic characteristics of the temperature of the interior of a processing room and/or the exterior and whenever [processed temperature] for

every zone, to presume whenever [actual processed temperature] based on each dynamic characteristics, and to control the output of the temperature control means corresponding to each zone based on the estimate further again.
[0018]
[Function] Since this invention is constituted as mentioned above, it can do so the outstanding operation effectiveness which is described below. That is, since according to this invention the interior of a processing room and/or the dynamic characteristics of an outside temperature and whenever [processed temperature] are taken into consideration, the temperature of a processed object is presumed and the output of a temperature control means is adjusted based on the estimate, it is quickly [correctly and] controllable by the processing temperature of a request of whenever [actual processed temperature].
[0019] Moreover, since the temperature of the processed object which cannot be known can be searched for using the dummy wafer with which the temperature detection means was installed at the time of actual processing and the temperature of the processed object, the interior of a processing room, and/or dynamic characteristics with an outside temperature can be approximated with the function of a primary or secondary delay system, the temperature of a processed object can be presumed simpler.
[0020] Furthermore, since the temperature of a processed object is dynamically presumed for every zone even if it is the case of a configuration of having two or more heating zones, a batch type can be heat-treated at more uniform processing temperature.
[0021]
[Example] The thermal treatment equipment constituted based on this invention is explained to a detail about one example applied to the low pressure CVD system of a vertical mold, referring to an accompanying drawing below.
[0022] The tube furnace 2 of the shape of a cylindrical shape which has the adiathermic crowning supported perpendicularly on the pedestal 1 which the low pressure CVD system shown in drawing 1 was constituted as a vertical mold heat treating furnace, and was fixed horizontally, The coil 4 of the shape of a cylindrical shape which has the crowning which consists of a quartz which vacated the predetermined spacing 3 inside the tube furnace 2, and was inserted in it, The heating means 5 which was spirally arranged by the inner circle wall of the above-mentioned tube furnace 2 and which consists of heaters, such as a resistance heating element, for example, The principal part consists of elevator styles 7 for going up and down the wafer boat 6 which consists of a quartz which can carry out array maintenance of a majority of two or more processed objects (or dummy wafer) W, for example, the semi-conductor wafers, perpendicularly in the level condition, and this wafer boat 6.

[0023] Furthermore, the inlet 8 which is open for free passage at the above-mentioned spacing 3 is installed in the pars basilaris ossis occipitalis of the above-mentioned tube furnace 2, and it is possible to supply cooling air in the above-mentioned spacing 3 by the air-supply fan 10 connected through the suitable manifold 9. Moreover, the exhaust port 11 which is open for free passage at the above-mentioned spacing 3 as well as the crowning of the above-mentioned tube furnace 2 is installed, and it is constituted so that it may be possible to exhaust the air in the above-mentioned spacing 3.
[0024] Moreover, the reactant gas supply line 12 connected through the flow rate control unit is established in the source of gas which is not illustrated at the pars basilaris ossis occipitalis of the above-mentioned coil 4, and it is possible to introduce predetermined reactant gas into the processing room 13 inside the above-mentioned coil 4. Furthermore the exhaust pipe way 14 connected to exhaust air means, such as a vacuum pump which is not illustrated, is connected to the pars basilaris ossis occipitalis of the above-mentioned coil 4, and it is constituted so that it may be possible to carry out vacuum suction of the inside of the above-mentioned processing room 13 to a predetermined pressure.
[0025] Moreover, by the above-mentioned wafer boat's 6 equipping with the lid 16 the bottom of attaching part 6a which holds the semi-conductor wafer (or dummy wafer) W in the shape of multistage through the heat insulating mould 15, and raising the above-mentioned wafer boat 6 by the above-mentioned elevator style 7 Since the above-mentioned lid 16 is able to close airtightly opening of the pars basilaris ossis occipitalis of the above-mentioned coil 4 At the time of processing, vacuum suction of the inside of the above-mentioned processing room 13 is carried out using the above-mentioned exhaust pipe way 14, and performing the exhaust air from the above-mentioned exhaust pipe way 10 further, it is constituted so that it may be possible to

introduce predetermined reactant gas in the above-mentioned processing room 13 from the above-mentioned reactant gas supply line 12.
[0026] Next, the temperature control system of the vertical mold heat treating furnace constituted as mentioned above is explained. The temperature control system is constituted from the temperature control section 18 for controlling the power converter 17, up heater 5a by which division arrangement is carried out, center-section heater 5b and lower heater 5c, and the power converter 17 for controlling the amount of heating of those heaters, for example, SCR, by plurality (the example of illustration the upper part, a center section, the lower part) along the array direction of the semi-conductor wafer W.
[0027] And temperature sensor 19a installed for every heating zone in a coil 4 so that the temperature control section 18 may be mentioned later, A/D-converter 18a for changing into digital electromotive force (temperature) data the electromotive force sent from the thermocouple of R type which consists of 19b and 19c, for example, platinum / platinum / rhodium, Wafer temperature presumption machine 18b which presumes wafer temperature based on the presumed type later mentioned from the above-mentioned temperature data, The output command value over a heater based on the wafer temperature presumed with the wafer temperature presumption vessel For example, output calculator 18c calculated with a PID algorithm, It consists of 18d of data converters for changing the command value over a heater into the signal which suits the input specification of a power converter 17 as digital value.
[0028] In addition, although the configuration which divides a heating zone into three and installs the temperature sensor corresponding to the interior of a coil 4 to each heating zone, respectively is adopted in the example of illustration, this invention is not limited to this configuration. For example, it is applicable also to the processor which heats the processing interior of a room with a single heating means, or the processor divided into the zone of the number of arbitration. Moreover, although installed in the above-mentioned example also about the temperature sensor corresponding to each heating zone of the coil 4 interior, this invention is not limited to this configuration. For example, if it is also possible to adopt the configuration which forms the temperature sensor of the exterior of a coil 4, and it is possible to perform dynamic related attachment of the temperature detected by the temperature sensor, whenever [processing room temperature], or, whenever [processed temperature] by presumed machine 18b so that it may mention later, a temperature sensor can install the number of arbitration in the location of the arbitration of the interior of a processing room, and/or the exterior.
[0029] Next, it explains, referring to drawing 1 about actuation of the low pressure CVD system formed as mentioned above.
[0030] 1. According to definite **** this invention of a presumed type, it is necessary to install the dummy wafer with which the temperature sensor was installed for every heating zone, to perform actual heat treatment and same processing, and to ask for the dynamic relational expression of the optimal dummy wafer temperature and the temperature detected by the temperature sensors 19a, 19b, and 19c installed in the coil 4. That is, power is impressed to the heating apparatus 5 first installed in the wall of a tube furnace 2 like actual heat treatment, a coil 4 is heated, and the internal temperature is raised even at 500 degrees C. Subsequently, a lid 16 is opened wide and the wafer boat 6 by which the dummy wafer was installed in the location corresponding to each heating zone is loaded. Although the temperature in a coil 4 descends in order that the interior of a coil 4 may be [initiation / of this boat load actuation] open for free passage with the open air, by completing boat load actuation and carrying out the closedown of the lid 16, the temperature in a coil 4 starts to go up, and is again converged on 500 degrees C after predetermined time termination. Then, after raising processing temperature, for example, 600 degrees C, further, raw gas, such as SiH4 gas, is introduced from the reactant gas supply line 12, and a dummy wafer is received. For example, after performing membrane formation processing of polish recon in the reduced pressure ambient atmosphere of 0.1Torr(s) and completing predetermined heat treatment, a series of actuation is ended by opening a lid 16 wide again, picking out the wafer boat 6 from a coil 4, and stopping a lid 16.
[0031] While the above-mentioned heat treatment is performed according to this invention, with and the thermometric element installed in the dummy wafer So that the temperature of a dummy wafer may become the optimal for every zone Heating apparatus 5a of each zone, The output of 5b and 5c is controlled, and the dynamic relations of the temperature of the dummy wafer in that case and the internal temperature sensors 19a, 19b, and 19c of a coil 4 are approximated by the following presumed type, and are stored in wafer temperature

presumption machine 18b.
[0032]
[Equation 5]
$$W(n) = \sum_{i=0}^{k} aiT(n-i)$$

[0033] However, estimate of whenever [processed temperature / in / a W(n):time / n];
T(n): Measurement temperature by the temperature detection means [in / a time / n];
a0 --ak: Constant which specifies the dynamic characteristics of measurement temperature and whenever [processed temperature];
[0034] 2. in processing to the processing-mode actual condition, power is impressed to the heating apparatus 5 first installed in the wall of a tube furnace 2, a coil 4 is heated, and it raises the internal temperature even at 500 degrees C. Subsequently, a lid 16 is opened wide and the semi-conductor wafer W which is a processed object loads the wafer boat 6 by which predetermined number-of-sheets installation was carried out to the location corresponding to each heating zone. And it is in the condition which decompressed the inside of a coil 4, predetermined pressures, for example, 0.1Torr(s), and it is possible by introducing raw gas, for example, SiH4 gas etc., from the reactant gas supply line 12 to perform membrane formation processing of desired polish recon to a processed object. And after predetermined heat treatment is completed, a series of actuation is ended by suspending supply of raw gas, opening a lid 16 wide, picking out the wafer boat 6 from a coil 4, and stopping a lid 16.
[0035] Temperature sensor 19a which was installed in the coil 4 interior according to this invention when performing temperature control of the above thermal treatment equipments, The temperature of the section of a reaction is supervised by 19b and 19c. Those temperature sensor 19a, 19b and 19c, for example, the electromotive force signal of a thermocouple, are changed into the temperature data of a fixed time interval by A/D-converter 18a, and wafer temperature is dynamically presumed in wafer temperature presumption machine 18b based on the above-mentioned presumed type from the temperature data. And the output command value over the heating means 5, such as a heater, based on the wafer temperature presumed in the above-mentioned wafer temperature presumption machine 18b For example, are calculated using a PID algorithm, and it is sent to 18d of data converters so that the output command value over the heater as digital value may suit the input specification of the power converters 17, such as SCR, further. The output of a power converter 17 is adjusted based on the signal from there, and the output of the heating means 5a, 5b, and 5c corresponding to each heating zone is adjusted.
[0036] Since each wafer temperature at the time is dynamically presumed based on the signal from a temperature sensor using the above operation mechanisms according to this invention, desired temperature control can be performed far more correctly than the conventional approach and quickly.
[0037] Next, the effectiveness which was excellent in this invention which is constituted as mentioned above and operates is explained, referring to drawing 2 and drawing 3 . for example, when wafer temperature is statically presumed with the signal from a temperature sensor like before When a temperature change as made carry out a temperature up to drawing 2 along with the lamp rise curve shown as a continuous line and shown with an alternate long and short dash line at the time of ** is detected For example, in fact, although the high thing was presumed only deltat degree C rather than detection temperature as a dotted line showed wafer temperature, and temperature control was performed based on it, since wafer temperature showed a delay system as a two-dot chain line shows, the actual condition was not able to perform exact and quick temperature control.
[0038] However, since the value near the wafer temperature shown with the two-dot chain line is presumed and temperature control is performed based on it as a dotted line shows for example, wafer temperature when a temperature up tends to be carried out along with a lamp rise curve as shown in drawing 3 as a continuous line according to this invention and a temperature change as shown with an alternate long and short dash line is detected, it becomes possible to perform more exact and quick temperature control.
[0039] In addition, in the above example, although the low pressure CVD system of a batch type was mentioned as the example and this invention was explained, this invention is not limited to this example and it cannot be overemphasized that it is possible an atmospheric pressure CVD system, dispersion equipment, an oxidation system, membrane formation equipment, and to apply also to the thermal treatment equipment of single wafer

processing further.
[0040]
[Effect of the Invention] Since according to this invention the interior of a processing room and/or the dynamic characteristics of an outside temperature and whenever [processed temperature] are taken into consideration, the temperature of a processed object is presumed and the output of a temperature control means is adjusted based on the estimate as explained above, it is quickly [correctly and] controllable by the processing temperature of a request of whenever [actual processed temperature].
[0041] Moreover, since the temperature of the processed object which cannot be known can be searched for using the dummy wafer with which the temperature detection means was installed at the time of actual processing and the temperature of the processed object, the interior of a processing room, and/or dynamic characteristics with an outside temperature can be approximated with the function of a primary or secondary delay system, the temperature of a processed object can be presumed simpler.
[0042] Furthermore, since the temperature of a processed object is dynamically presumed for every zone even if it is the case of a configuration of having two or more heating zones, a batch type can be heat-treated at more uniform processing temperature.

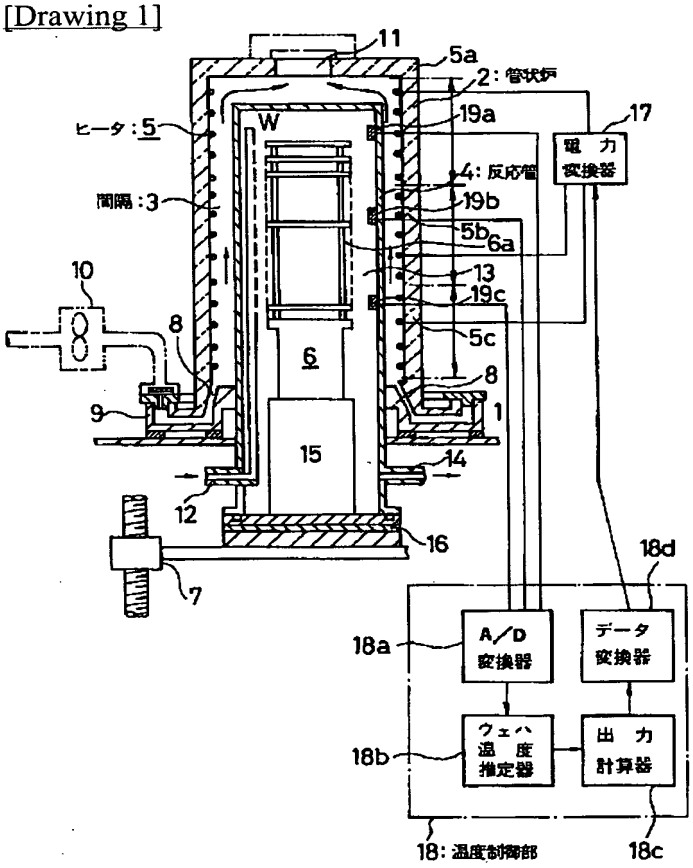
[Translation done.]

* NOTICES *

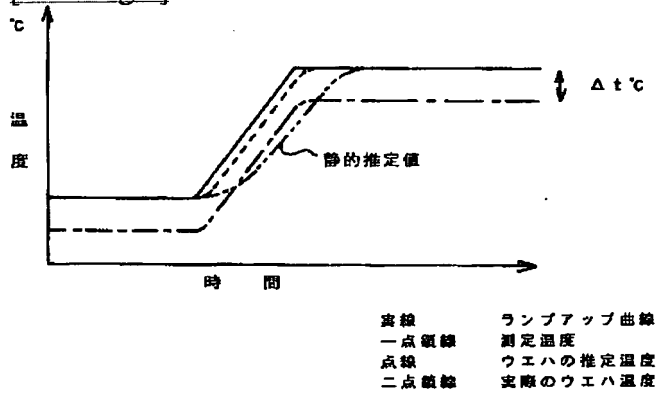
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

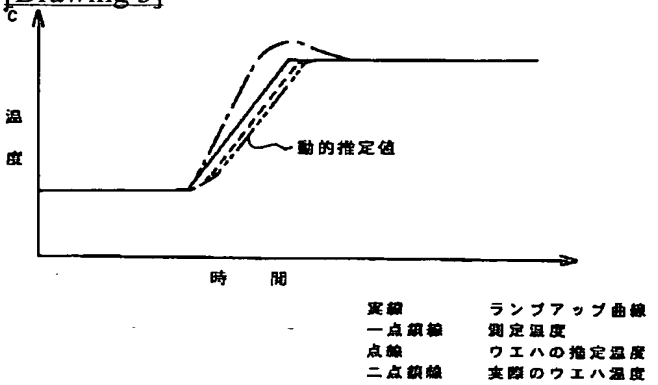
[Drawing 1]



[Drawing 2]



[Drawing 3]



[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CORRECTION OR AMENDMENT

[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
[Section partition] The 2nd partition of the 7th section
[Publication date] November 9, Heisei 13 (2001. 11.9)

[Publication No.] JP,7-283158,A
[Date of Publication] October 27, Heisei 7 (1995. 10.27)
[Annual volume number] Open patent official report 7-2832
[Application number] Japanese Patent Application No. 6-96951
[The 7th edition of International Patent Classification]

H01L 21/22 511
21/205

[FI]

H01L 21/22 511 A
21/205

[Procedure revision]
[Filing Date] March 12, Heisei 13 (2001. 3.12)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim 1
[Method of Amendment] Modification
[Proposed Amendment]
[Claim 1] In the thermal treatment equipment for heat-treating the processed object arranged in the processing interior of a room with the raw gas which carried out the temperature up with the temperature control means installed in the exterior of the processing room, and was introduced into the processing interior of a room,
The presumed machine which presumes the temperature of a processed object based on the signal from the temperature detection means currently installed in the interior and/or the exterior of said processing room,
The thermal treatment equipment characterized by having a temperature selector for calculating and controlling the output of said temperature control means based on estimate with the presumed machine.
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim 4
[Method of Amendment] Modification
[Proposed Amendment]
[Claim 4] In heat-treating the processed object arranged in the processing interior of a room with the raw gas which carried out the temperature up with the temperature control means installed in the exterior of the processing room, and was introduced into the processing interior of a room,
The temperature control approach of a thermal treatment equipment which acquires beforehand the dynamic characteristics of the temperature of the interior of a processing room, and/or the exterior, and whenever

[processed temperature], presumes whenever [actual processed temperature] based on the dynamic characteristics, and is characterized by controlling the output of said temperature control means based on the estimate.
[Procedure amendment 3]
[Document to be Amended] Specification
[Item(s) to be Amended] 0008
[Method of Amendment] Modification
[Proposed Amendment]
[0008]
[Means for Solving the Problem] In order that this invention may solve the above-mentioned technical problem, invention according to claim 1 carries out the temperature up of the processed object arranged in the processing interior of a room with the temperature control means installed in the exterior of the processing room, and is characterized by the thermal treatment equipment for heat-treating with the raw gas introduced into the processing interior of a room possessing the following. The presumed machine which presumes the temperature of a processed object based on the signal from the temperature detection means currently installed in the interior and/or the exterior of said processing room The temperature selector for calculating and controlling the output of said temperature control means based on estimate with the presumed machine
[Procedure amendment 4]
[Document to be Amended] Specification
[Item(s) to be Amended] 0013
[Method of Amendment] Modification
[Proposed Amendment]
[0013] Furthermore, the temperature up of the processed object which has been arranged in the processing interior of a room according to claim 4 is carried out with the temperature control means installed in the exterior of the processing room. In heat-treating with the raw gas introduced into the processing interior of a room, the dynamic characteristics of the temperature of the interior of a processing room and/or the exterior and whenever [processed temperature] is acquired beforehand. Whenever [actual processed temperature] is presumed based on the dynamic characteristics, and the temperature control approach of a thermal treatment equipment characterized by controlling the output of said temperature control means based on the estimate is offered.

[Translation done.]